

Claims

What is claimed is:

1. A method for multilevel coding of a stream of information bits in a communication system, the method comprising the steps of:

5                 separating the stream of information bits into a plurality of different portions;  
               associating each of the portions of the information bits with one of a plurality of levels;

10                 applying at least one code to the portion of the information bits of each level in a designated subset of the plurality of levels, such that the portions of the information bits for one or more levels in the designated subset are coded while the portions of the information bits for one or more levels not in the designated subset are uncoded;

utilizing both the coded portions of the information bits and the uncoded portions of the information bits to select modulation symbols for transmission in the system.

15                 2. The method of claim 1 wherein the stream of information bits comprises a stream of source-coded information bits.

3. The method of claim 1 wherein there are a total of  $m$  of the levels, and the modulation symbols are selected from a signal set of a  $2^m$  modulation constellation.

20                 4. The method of claim 1 wherein the at least one code comprises a block code.

5. The method of claim 1 wherein the at least one code comprises a block code concatenated with a convolutional code.

25                 6. The method of claim 1 wherein the at least one code comprises a cyclic redundancy check (CRC) code.

7. The method of claim 1 wherein there are a total of  $m$  of the levels, arranged from a lowest level to a highest level, and the designated subset of levels includes at least the lowest level.

8. The method of claim 1 wherein there are a total of  $m$  of the levels, arranged from a lowest level to a highest level, and the designated subset includes a series of  $i_{max}$  adjacent levels beginning with the lowest level, where  $i_{max}$  is less than  $m$ .

9. The method of claim 8 wherein  $m$  is equal to five, and  $i_{max}$  is equal to four, such that there are a total of five levels, one of which is an uncoded level and four of which are coded levels.

10 10. The method of claim 8 wherein  $m$  is equal to five, and  $i_{max}$  is equal to three, such that there are a total of five levels, two of which are uncoded levels and three of which are coded levels.

15 11. The method of claim 8 wherein  $m$  is equal to five, and  $i_{max}$  is equal to two, such that there are a total of five levels, three of which are uncoded levels and two of which are coded levels.

12. The method of claim 8 wherein  $m$  is equal to four, and  $i_{max}$  is equal to three, such that there are a total of four levels, one of which is an uncoded level and three of which are coded levels.

20 13. The method of claim 8 wherein  $m$  is equal to four, and  $i_{max}$  is equal to two, such that there are a total of four levels, two of which are uncoded levels and two of which are coded levels.

25 14. The method of claim 8 wherein the portion of the information bits for each of the levels of the designated subset has at least a block code applied thereto, and wherein rates for the block codes applied to the portions of the information bits for the series of  $i_{max}$  adjacent levels beginning with the lowest level are selected so as to have increasing code rates from a lowest code rate for the block code associated with the lowest level to a highest code rate for the block code associated with the highest of the levels in the series of  $i_{max}$  adjacent levels.

15. The method of claim 8 wherein each of a plurality of lowest levels  $j = 1, \dots, j_{max}$  includes a block code concatenated with a convolutional code, where  $j_{max}$  is greater than or equal to one but less than or equal to  $i_{max}$ .

5        16. The method of claim 1 wherein the stream of information bits comprises at least one frame of information bits, and each of the portions of the stream of information bits comprises a different class of bits within the at least one frame, and wherein the at least one code is selected so as to provide different amounts of error protection for at least a subset of the different classes of bits.

10      17. The method of claim 1 wherein the stream of information bits comprises a plurality of frames of information bits, and each of the portions of the stream of information bits comprises at least a part of a particular one of the frames.

15      18. The method of claim 1 wherein the stream of information bits comprises a plurality of frames of information bits, and each of the portions of the stream of information bits comprises at least a part of each of the plurality of frames, the particular part of a given one of the frames corresponding to one of the portions including bits of the given frame associated with a class of bits to be provided with a designated amount of error protection.

20      19. The method of claim 1 further including the step of decoding received versions of the selected modulation symbols in a multilevel decoder.

25      20. The method of claim 1 wherein a total code rate provided taking into account the coded portions and the uncoded portions of the information bits is approximately 0.8.

21. The method of claim 1 wherein there are a total of  $m = 5$  levels, and a lowest one of the five levels has a code rate approximately in a range of about 0.2 to 0.3, the next highest one of the levels has a code rate approximately in a range of about 0.8 to 0.9, and the next highest one of the levels has a code rate greater than about 0.9.

22. The method of claim 1 wherein there are a total of  $m = 4$  levels, and a lowest one of the four levels has a code rate approximately in a range of about 0.2 to 0.3, and the next two highest levels have code rates higher than about 0.9 and 0.95, respectively.

5        23. An apparatus for multilevel coding of a stream of information bits in a communication system, the apparatus comprising:

an multilevel encoder receiving a stream of information bits separated into a plurality of different portions, each of the portions of the information bits being associated with one of a plurality of levels, the encoder being operative to apply at least one code to the portion of the information bits of each level in a designated subset of the plurality of levels, such that the portions of the information bits for one or more levels in the designated subset are coded while the portions of the information bits for one or more levels not in the designated subset are uncoded; and

10        a modulator having an input coupled to an output of the multilevel encoder, the modulator utilizing both the coded portions of the information bits and the uncoded portions of the information bits to select modulation symbols for transmission in the system.

15        24. An article of manufacture for storing software for use in multilevel coding of a stream of information bits in a communication system, the stream of information bits being separated into a plurality of different portions, each of the portions of the information bits being associated with one of a plurality of levels, wherein the software when executed implements the steps of:

20        applying at least one code to the portion of the information bits of each level in a designated subset of the plurality of levels, such that the portions of the information bits for one or more levels in the designated subset are coded while the portions of the information bits for one or more levels not in the designated subset are uncoded;

25        utilizing both the coded portions of the information bits and the uncoded portions of the information bits to select modulation symbols for transmission in the system.

25. A method for decoding of a multilevel coded stream of information bits in a communication system, the multilevel coded stream of information bits being coded by separating

the stream of information bits into a plurality of different portions, associating each of the portions of the information bits with one of a plurality of levels, and applying at least one code to the portion of the information bits of each level in a designated subset of the plurality of levels, such that the portions of the information bits for one or more levels in the designated subset are coded while the  
5 portions of the information bits for one or more levels not in the designated subset are uncoded, the method comprising the steps of:

demodulating received versions of the modulation symbols to obtain outputs corresponding to each of the plurality of levels; and

10 decoding each of the outputs associated with a given level in the designated subset so as to obtain a received version of the corresponding portion of the information bits.

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